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A CRITICAL ANALYSIS OF PARASITIC RESEARCH ON SOME DOMESTICATED ANIMALS OF PAKISTAN

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ABSTRACT

Parasitic diseases are responsible for heavy economic losses to livestock industry particularly due to lowered productivity of the affected animals. Many workers across the country have identified and reported high prevalence of a wide variety of parasitic diseases affecting different species of animals. This paper presents an overview of the occurrence of various types of parasites in cattle, buffaloes, sheep, goats and poultry in Pakistan. Moreover, weak areas in the research on parasitic diseases have been identified and recommendations for future research have been given.

INTRODUCTION

Food from animal sources is not only important due to its nutritive value, but also because of its crucial need to cater the needs of tremendously growing human population. The parasites because of their adverse effects lead to lowered productivity, retarded growth rate and even death of animals (FAO, 1974; Barger, 1982; Steel & Symons, 1982; Sykes, 1982; Holmes, 1986; Sykes, 1994). Multidimensional approaches are in practice for an effective control of helminths. These include periodical use of anthelmintics and vaccination programs coupled with improved management. However, increasing problems of development of resistance in helminths (Waller and Prichard, 1985) against anthelmintics, chemical residual/toxicity problems (Kaemmerer and Butenkotter, 1973) and antigen complexity of parasites have always led to the alternate proposals. These include control programs based on epidemiological information of a disease in local conditions, and exploiting anthelmintic potential of different chemicals/agents. This paper presents a review of prevalence of different parasites and the evaluation of some antiparasitic drugs.

CATTLE AND BUFFALOES

Helminths:

In Azad Kashmir, Chaudhry et al. (1984) reported Fasciola (F.) hepatica (70%), Cotylophoron (C.) cotylophorum (5%), Ostertagia (O) ostertagi (64.6%), Haemonchus (H.) contortus (58.5%) and Ascaris vitulorum (48%) infecting cattle and buffaloes. Hussain et al. (1986) recorded 76.7% buffalo calves (< 1 year) to harbour gastrointestinal parasites in and around Livestock Production Research Institute, Bahadurnagar (Okara); the rate of infection being higher (80.9%) in males and lower (74.4%) in females; species of helminths recorded were Strongyloides papillosus, Neoascaris vitulorum, Oesophagostomum (Oe) radiatum, O. ostertagi, Bunostomum (B.) phlebotomum, H. contortus, Nematodirus spp., Moniezia (M.) benedeni and M. expansa. Ahmad (1995) reported helminthiasis in 65.79% buffaloes at Lahore; species included H. contortus (11.84%), H. placei (10.53%), O. ostertagi (7.89%), Trichostrongylus (T.) axei (3.95%), T. colubriformis (7.89%), Mecistocirrus digitatus (2.63%), Cooperia (Co.) onchophora (9.21%), Co. punctata (5.26 %), Co. pectinata (6.58%), Nematodirus (N.) helvetianus i]=8(2.63%), B. phlevotomum (2.63%), Strongyloides (S.) papillosus (2.63%), Oe. radiatum (3.95%), Trichuris (Tr.) globulosa (1.32%) and M. benedeni (2.63%). Anwar et al.

(1996) reported 63.8% buffalo calves having gastrointestinal helminthiasis at Faisalabad; the species recorded were S. papillosus, Toxocara (To.) vitulorum, Trichostrongylus species, O. ostertagi, Oe. radiatum, Cooperia spp., M. benedeni, B. phlebotomum, M. expansa and Nematodirus spp.

Masud and Majid (1984) recorded ascaris infection in 41.94% buffalo-calves and 35.08% cow-calves in Multan Divison. Muhammad *et al.* (1986) recorded *Parafilaria bovicola* infection in cattle from Faisalabad. Hayat *et al.* (1990) reported prevalence of *To. vitulorum*, 1.7 and 36.6% in adult and two months old buffalo calves, respectively. Afzal (1992) reported 63% sheep having intestinal nematodes in Bahawalpur; species recorded were *Oe. venulosum, Oe. columbianum, Tr. ovis, Tr. globulosa, N. spathiger, H. contortus, T. colubriformis* and *T. axei*. Javed *et al.* (1993) recorded higher (14.43%) prevalence of endoparasites in buffalo and cattle calves under one year of age compared with that (7.15%) from 1-3 years of age at Bahadurnagar (Okara) and Qadirabad (Sahiwal); species identified were Oesophagostomum, *Mecistocirrus digitatus*, Bunostomum, Strongyloides spp. and *H. contortus*.

Siddiqi and Shah (1984) reported *F. hepatica* in 55% and *Paramphistomum (P.) cervi* in 40% cattle livers at Peshawar. In Multan division, highest infestation of liver fluke was noted in buffalo (23.97%) and cattle (5.95%) in February; buffalo-calves and cow calves being highly (10.16% and 12.5%) infected in June and January, respectively; highest prevalence, 10.4% in buffaloes and 11.81% in cattle was recorded in animals above seven years of age (Masud and Majid, 1984a). Gill (1985) conducted a survey for Schistosomiasis in cattle and buffaloes around Raubwa (District Jhang) and reported 13% animals being positive by faecal examination. The species of snails recorded in the area were four genera, viz., Lymnaea, Bullinus, Indoplanorbis and Planorbis being 49, 21, 24, and 6% prevalent, respectively. Akbar (1989) reported Paramphistomes from 79.5% buffaloes of Lahore; species included *P. cervi* (56.50%), *C. cotylophorum* (52.50%), *Gastrothylax (G.) crumenifer* (35.50%) and *Carmyerius spatiosus* (24,50%). Bhatti (1991) reported 19.39% buffaloes in Gujrat positive for trematodes. Sahar (1991) reported 37.5 % buffaloes at Lahore were infected with *F. hepatica and F. gigantica*. Ahmad (1995) reported *P. cervi* (3.95%) and *P. microbothrium* (2.63%) in buffaloes from Lahore. In buffaloes from Faisalabad, Zar (1996) reported paramphistomes in the rumen (38.4%) and gall bladder (0.2%), incidence being highest (73%) in August and the lowest in November (5%); the species recorded were *P. cervi* (55%), *C. cotylophorum* (27%), *G. crumenifer* (15%) and *Gigantocotyle explanatum* (3%). Cheema (1997) reported 75.07% buffaloes and 50.7% cattle having amphistomiasis in Pakistan.

Hydatidosis has been reported being 49.09% in buffaloes, 5.74% in buffalo calves, 33% in cattle and 3.9% in cattle calves in Faisalabad (Munir, 1981), in 20% livers and 2.5% lungs of cattle at Peshawar (Siddiqi and Shah, 1984), in 31.05% cattle in Rawalpindi-Islamabad (Pal and Jamil, 1986) and in 19% buffaloes at Lahore (Khan *et al.*, 1990). Ashraf (1994) recorded cestodes in 65.5% sheep at Lahore; species reported were *M. expansa* (64%), *M. benedeni* (60%), *Avitellina (A.) centripunctata* (49.5%), *A. lahorei* (40%), *A. sudanea* (30%), *Stilesia (St.) villata* (30%), *St. globipunctata* (50%), *Thysanosoma (Th.) actinioides* (6%).

Basra (1991) examined sheep for lungworms at Lahore and reported 25% having *Dictyocaulus (Di.) filaraia*, 8.33% having *Protostrongylus (Pr.) rufescens* and 66.67% with mixed infection of both the species. Sherazi (1994) found 31% sheep and 11% goats in Lahore having infection with one or the other lungworms of the species of *Di. filaria, Pr. rufescens* and *Muellerius (Mu.) capillaris*.

Protozoa:

Murtaza (1988) recorded three species of coccidia namely *Eimeria (E.) zuernii, E. bovis* and *E. cylindrica* prevalent in cattle and buffaloes at Lahore. Buriro *et al.* (1994) reported Anaplasma, Theileria and Babesia from cattle (*Bos indicus)* and buffaloes (*Bubalus bubalis)* in Hyderabad district. Hayat *et al.* (1994) reported coccidiosis in diarrhoeic cases being 28.9 and 29.1%; and in apparently healthy animals being 13.7 and 13.8%

in cattle and buffaloes, respectively at Faisalabad; species of coccidia were: *E. zurnii, E. bovis, E. cylindrica* and *E. ellipsoidalis,* prevalence being higher in calves < one year of age, and in autumn and spring as compared to summer and winter. Afzal (1996) investigated coccidia in cattle and buffalo calves and reported 20.46% animals being infected with four species viz. *E. zuerni* (48.0%), *E. bovis* (27%), *E. cylindrica* (16%) and *E. ellipsoidalis* (10%).

Ectoparasites:

Kausar (1965) identified only one species viz. *Rhipicephalus (R.) sanguineus* parasitizing sheep, goat, cattle, buffaloes, equines and dogs in Lyallpur district; three generations of this tick occurred in one year, population built up being heaviest in June, a minor peak of abundance in the last week of September, a decline in October and the lowest prevalence in November. Khan (1967) identified seven species of Hyalomma ticks viz., *Hyalomma (H.) aegyptiam, H. kumari, H. bussaini, H. anatolicum anatolicum, H. dromedarii, H. marginatus isaaci* and *H. marginatum turanigum,* parasitizing sheep, goats, cattle, buffaloes and camels in West Pakistan; most prevalent during June, July and August and comparatively absent during December to February. In Faisalabad, Iqbal (1971) recorded *H. aegyptium, H. anatolicum anatolicum, Boophilus (B.) microplus, Haematopinus eurysternus* and Psoroptes mites from buffaloes; and *H. aegyptium, H. anatolicum anatolicum, B. microplus, Linognathus vituli* and *Hypoderma lineatum* from cattle. Ali (1988) reported *Psoroptes (P.) bovis* (56.0%) and *P. natalensis* (44.0%) in buffaloes; *P. bovis* (30.43%), *P. ovis* (21.74%) and *P. natalensis* (47.83%) in cattle. Durrani (1992) reported *Haemaphysalis brunati* in 3.87% sheep, goat cattle and buffaloes at Lahore. In Faisalabad, Khan *et al.* (1993) recorded tick infestation in 28.2% cattle and 14.7% buffaloes; seven species of ticks viz., *R. sanguineus, B. microplus, B. annulatus, H. anatolicum anatolicum, H. aegyptium* and *Dermacentor marginatus* were identified. Qudoos *et al.* (1995) reported mite infestation in 9.3 cattle and 45.3% buffaloes in district Faisalabad; two species of mites viz., *Sarcoptes scabiei var. bovis* and *Psoroptes ovis* were identified.

SHEEP AND GOATS

Helminths:

Khan (1985) conducted a survey of gastro-intestinal heiminthiasis in sheep and goats at Faisalabad and reported 58.4% sheep and 54.4% goats to be infected with helminths: *P. cervi, P. explanatum, C. cotylophorum, M. expansa, M. benedeni, Av. centripunctata, H. contortus, Oe. venulosum, B. trigonocephalum, Chabertia (Ch.) ovina, Co. cruticei, Tr. ovis, O. circumcincta and O. ostertagi,* highest prevalence being in the month of August. The incidence of various species of the gastro-intestinal nematodes was found to be 72 and 54% in sheep and goats, respectively in Lahore; species recorded included *H. contortus, O. circumcincta, O. ostertagi, B. trigonocephalum, Co. curticei, Oe. venulosum, Tr. ovis* and *Ch. ovina* (Naseem *et al.*, 1987). Pal and Qayyum (1992) reported Balkhi breed of sheep and Kaghani breed of goats being the main victims of gastrointestinal helminthiasis, particularly the animals of more than two years of age; likewise, female goats having higher (89.94%) rate of infection than males (78.57%). Malik *et al.* (1995) recorded Ostertagia, *M. expansa, F. gigantica* and *F. hepatica* from sheep and goats in Punjab. Pal and Qayyum (1993) reported *H. contortus*, Ostertagia species, Trichostrongylus species, *B. trigonocephalum* and *Skrjabinema ovis* from sheep and goats in districts of upper Punjab. Hafeez (1996) reported gastrointestinal parasites in 68.5% sheep in Lahore, sprozoan being 51%, trematodes 21%, cestodes 62% and nematodes 68%. Rafique *et al.* (1997) reported 87.7% sheep being infected with *N. spathiger, Tr. globulosa, Marshallagia marshalli* and *S. papillosa* from Quetta and Kalat (Kovak and Zarchi valleys), Balochistan.

Maqsood (1993) reported 65.2% in sheep and 47.1% in goats in Faisalabad to be infected with *H. contortus.* In another study in the same area, 21.7% sheep and 10.9% goats were reported to have haemonchosis (Iqbal *et al.*,

1993). The rate of infection in both the sexes is quite conteroversial. Maqsood *et al.* (1996) reported higher prevalence (74.6%) in female than in male (59.1%) sheep; whereas, Iqbal *et al.* (1993) have reported higher rate of infection in males compared with female sheep. There was no difference in the prevalence of haemonchosis between male and female goats (Maqsood *et al.*, 1996). The prevalence of haemonchosis was found higher in both sheep and goats less than two years of age (67.1%;47.8%) compared with those of above two years being 40.4 and 33.3 %, respectively (Maqsood *et al.*, 1996).

Majid (1980) reported trematodes in sheep slaughtered at Lahore abattoir with an incidence 59.37%; species recorded were *P. cervi* (36.25 %), *C. cotylophorum* (21.87%), *F. hepatica* (3.12%), *F. gigantica* (3.12%) and *Dicrocoelium (D.) dendriticum* (0.94%). Anwar and Chaudhri (1984) reported 58.5% sheep and goats infected with *F. hepatica* in Faisalabad Iqbal *et al.* (1986) reported fascioliasis in sheep and goats (Faisalabad) being 18 and 10%, respectively involving two species viz. *F. gigantica* and *F. hepatica*. Saleem *et al.* (1986) recorded an incidence of 8 and 4% for *F. hepatica* and *F. gigantica*, respectively in sheep from Lahore; whereas it was 17.58% for both these species in Faisalabad; being highest (30%) in November and lowest (4%) in June (Hayat *et al.*, 1986a). Hameed (1996) reported 64.25% sheep and goats in Lahore to have trematode infection; species recorded were *P. cervi* (23.75%), *F. hepatica* (29.75%), *D. dendriticum* (10.75%).

Hayat (1965) reported 21.4% lungs of sheep to be infected with *Di. filaria*, 8.6% with *Pr. rufescens* and 0.6% with *Mu. capillaris;* infestation of *Di. filaria* was higher during the months of September, October and November and lower during the months of April, May and June; occurrence of *Pr. rufescens* was found to be higher during the months of May, June and July. Iqbal *et al.* (1986) reported *Di. filaria* from 3% and *Pr. rufescens* from 2% lungs of sheep at Faisalabad. Basra (1991) examined sheep for lungworms at Lahore and reported 25% having *Dictyocaulus (Di.) filaraia*, 8.33% having *Protostrongylus (Pr.) rufescens* and 66.67% with mixed infection of both the species. Sherazi (1994) found 31% sheep and 11% goats in Lahore having infection with one or the other lungworms of the species of *Di. filaria*, *Pr. rufescens* and *Muellerius (Mu.) capillaris*.

Majeed (1968) recorded three species of Stilesia viz., *St. globipunctata*, *St. vittata* and *St. sarwari* parasitizing 48.8% sheep and goats slaughtered at Lyallpur abattoir; infestation being the highest during July, August and September. Yusuf (1968) reported 43% sheep and goats at Faisalabad to be infected with Avitellina species viz., *Av. centripunctata*, *Av. lahorea*, *Av. sudanea* and *Av. woodlandi*. Hashmi and Mohiuddin (1978) recorded three anoplocephalid genera, viz, Moniezia, Stilesia and Avitellina from sheep and goats in Hyderabad; highest incidence recorded in fall (September-October) and the lowest in late summer (July-August). Ashraf (1994) recorded cestodes in 65.5% sheep at Lahore; species reported were *M. expansa* (64%), *M. benedeni* (60%), *Avitellina (A.) centripunctata* (49.5%), *A. lahorei* (40%), *A. sudanea* (30%), *Stilesia (St.) villata* (30%), *St. globipunctata* (50%), *Thysanosoma (Th.) actinioides* (6%).

Iqbal *et al.* (1986) reported hydatidosis in sheep and goats (Faisalabad) being 24 and 8%, respectively. Hayat *et al.* (1986) recorded hydatidosis in 24% sheep at Faisalabad, being 12% in lungs, 8% in livers and 4% in both these organs. In Rawalpindi-Islamabad, the prevalence of hydatidosis was recorded as 1.79% in goats and 5.30% in sheep (Pal and Jamil, 1986). The prevalence of hydatidosis in teddy goats at Faisalabad was 8%; being 4.58% in males and 14.5% in females (Iqbal *et al.*, 1986a). Haq (1986) recorded echinococcus cysts in 2.834% sheep and 0.432% goats at Faisalabad. Ashraf *et al.* (1986) reported an incidence of hydatidosis as 24% in sheep and 19% in goats. Anwar *et al.* (1993) reported hydatidosis in 2.83% in sheep being 1.57% in male and 4.95% in female; and in goats it was 0.43% being 0.55% in males and 0.21% in females.

Protozoa:

Khan (1982) reported coccidiosis in 23.07% sheep and goats at Lahore; species identified were *E. arloingi*, *E. intricata*, *E. parva*, *E. faurei* and *E. pallida*. Bano and Jan (1986) recorded *Trypanosoma melophagium* in 16%

sheep in N.W.F.P; with a new record of *Trypanosoma deriensis* in naturally infected goats having an incidence of 9.86%.. Sherazi (1991) reported *E. ovina, E. intricata, E. parva, E. faurei* and *E. ninakohliakimovae* (30%) infecting sheep at Lahore. Ahmad (1992) found teddy goats infected with *E. arloingi, E. intricata, E. parva, E. faurei* and *E. ninakohlyakimovae* at Lahore.

Ectoparasites:

The ticks *R. sanguineus* (Kausar, 1965) and Hyalomma (Khan, 1967; Iqbal, 1971) were found parasitizing sheep and goats in Lyallpur district. Durrani (1992) reported *Haemaphysalis brunati* in 3.87% sheep at Lahore. Rana (1993) reported 15% sheep with mange/mite infection with genera Sarcoptes, Psoroptes and Chorioptes at Lahore. Nasir (1995) reported *Damalina ovis* (10.5%), *Linognathus pedalis* (1%) from sheep in Lahore, highest incidence was recorded during spring and autumn and lowest summer. Khan (1993) identified *R. sanguineus* ticks from sheep and goats of Kaghan valley. Khan *et al.* (1993) reported tick infestation 18.8% sheep and 12.3% goats from Faisalabad; species of ticks were *R. sanguineus, B. microplus, B. annulatus* and *H. anatolicum anatolicum.*

POULTRY

Helminths

The prevalence of helminths in indigenous and exotic poultry has been frequently reported and varies from 1% to 85% depending upon the species of worm and the geographic origin (Anwar *et al.*, 1991; Buriro *et al.*, 1989; Chauhan, 1964; Elahi, 1982; Kazam, 1969). Various species of helminths reported from different places of Pakistan include *Raillietina tetragona* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983; Buriro *et al.*, 1985; Chauhan, 1964; Shah, 1995), *R. cesticillus* (Anwar *et al.*, 1991; Chauhan, 1964; Shah, 1995), *R. echinobothrida* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983; Buriro *et al.*, 1985; Chauhan, 1964; Shah, 1995), *R. pseudoechinobothrida* (Chauhan, 1964), *Cotugnia digonopora* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Buriro *et al.*, 1985), *Choanotanenia infundibulum* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983; Buriro *et al.*, 1985; Shah, 1995) *Amoebotaenia sphenoides* (Bano *et al.*, 1989; Buriro *et al.*, 1985), *Ascaridia galli* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983; Buriro *et al.*, 1985; Elahi, 1982; Yusuf, 1972) *Heterakis gallinarum* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983; Kazam, 1969), *Subulura brumpti* (Bano *et al.*, 1989; Anwar *et al.*, 1991; Hayat and Hayat, 1983), *Syngamus trachea* (Bano *et al.*, 1989), *Hymenolepis carioca* (Anwar *et al.*, 1991 ; Hayat and Hayat, 1983; Shah, 1995), *Amoebotaenia cuneata* (Shah, 1995) and *Hymenolepis cantaniana* (Shah, 1995). Kazam (1969) reported *Heterakis gallinae* from Lyallpur (Faisalabad), rate of infection in the months of April, May and June being 5, 12.5 and 12.5%, respectively. The infestation of *Raillietina tetragona* was found to be highest during July, August and September and lowest during December, January and February (Chauhan, 1964). The rate of infection of *Ascaridia galli* was found 15.4, 13.9, 37.9 and 41.5% in February, March, April and September, respectively (Yusuf, 1972). Buriro *et al.* (1989) reported prevalence of endoparasites being higher in Sukkur division than that in Hyderabad/Karachi divisions. The seasonal variation in the incidence of endoparasites showed high rate of infection in winter i.e. last quarter of the year (October-December) which subsequently decreased till 3rd quarter.

Protozoa:

In poultry, different parasitic diseases have been reported from various places of Pakistan. These include coccidiosis, helminths and ectoparasite infestations. Coccidiosis has been ranked at the top because of its prevalence and economic significance. Dar (1973) reported 10.23% fowls infected with coccidiosis in Lyallpur (Faisalabad) city; 9.71% with the caecal coccidiosis, and 0.52% with intestinal coccidiosis. Saleem (1991)

reported an overall prevalence of coccidia in poultry litter as 28.92%, being 34.31% and 23.52% at broiler and layer farms, respectively at Faisalabad. In the litter of broiler and layer under flocks below three weeks of age, the prevalence was 23.52% and 20.58%, respectively. The prevalence was 64.70% and 38.23%; 14.70% and 11.76% in the flocks between 3-6 and above six weeks of age in litter of broiler and layer farms, respectively. Different species of coccidia recorded include *E. acervulina* (Dar, 1973; Saleem, 1991; Hayat and Hayat, 1983; Anwar *et al.*, 1991), *E. mitis* (Dar, 1973; Saleem, 1991; Hayat and Hayat, 1983), *E. maxima* (Dar, 1973; Saleem, 1991; Hayat and Hayat, 1983), *E. tenella* (Dar, 1973; Saleem, 1991; Hayat and Hayat, 1983; Anwar *et al.*, 1991), *E. necatrix* (Saleem, 1991; Hayat and Hayat, 1983; Anwar *et al.*, 1991), *E. praecox* (Saleem, 1991; Hayat and Hayat, 1983). Iqbal *et al.* (1995) reported commercial quails (69%) to be infected with *E. bateri*. Bano *et al.* (1989) recorded *Aegyptianella pullorum* and *Haemoproteus columbae* from 8.99% poultry in Lahore.

Ectoparasites:

Sheikh (1969) identified *Argas reflexus reflexus, Argas vespertillionsia, Argas persicus* and *Argas abdussalami* ticks from poultry houses, bird hosts, bat hosts, burrows and rodent nests; the prevalence was comparatively much lower during the months of December, January and February. Shahjehan and Iqbal (1995) reported five species of lice viz. *Menopon gallinae, Menacanthus stramineus, Cuclutogaster heterographus, Goniocotes gigas* and *Goniodes dissimilis* from chicken of Peshawar and Mansehra; rate of lice infestation was 61.72%, the predominant species at Mansehra was *Cuclutogaster heterographus* (74.90%), while at Peshawar, it was *Menacanthus stramineus* (59.47%).

CONTROL/TREATMENT

Yusuf *et al.* (1984) found 100% reduction in EPG counts in Afghan sheep infected with Haemonchus, Cooperia, Marshallagia, Trichostrongylus, Chabertia, Dictyocaulus and Oesophagostomum species after 48 hours of medication with 10 ml/kg of morantal tartrate (4% sol) or 10 mg/kg body weight of mebendazole. Ovicidal effect of cattle urine against Fasciola eggs in cattle manure has also been reported (Marwat *et al.*, 1984). Hayat *et al.* (1985) reported 97% reduction in faeeal egg count in buffalo calves having ascarid infection treated with morantel tartrate (Banminth-II). Ali (1987) reported levamisole being 99.57% effective in eliminating the nematode worm burden; whereas, albendazole cleared 98.29% infection. Anwar *et al.* (1996) reported highest efficacy of Valbazen (88.8–97.6%) against gastrointestinal helminths in buffalo calves followed by Nilverm (81–95.7%) and Chanazole (70.4–90.5%). Ivermectin @ 200 μg per kg body weight was found effective against *Parafilaria bovicola* infection in cattle (Muhammad *et al.*, 1986).

Akhtar *et al.* (1983) reported santonin @ 15 mg/kg and afsanteen @ 1g/kg being equieffective to piperazine @ 88 mg/kg for the treatment of ascariasis in buffalo-calves. Riffat *et al.* (1986) reported *Morus alba* stem bark powder being an effective anthelmintic @ 3 g/kg against nematodes and cestodes in sheep. Akhtar and Riffat (1984) found that oral administration of 30 mg/kg of *M. azedarach* and 10 mg/kg of morantel tartrate are equieffective in the treatment of mixed gastrointestinal nematodal infections in the goats. Akhtar and Hassan (1985) reported that the oral administration of 2 mg/kg of the *Saussurea lappa* powder or equivalent amount of its methanol extract and 10 mg/kg of morantal tartrate are equipotent to morantel tartrate in the treatment of mixed gastrointestinal nematode infection in sheep.

The efficacy of triclabendazole, rafoxanide and albendazole in sheep naturally infected with *F. gigantica* and *F.hepatica* was recorded as 100, 97.1 and 95.7%, respectively (Maqbool *et al.*, 1992). The effcacy of Diamphenithide (Coriban), Niclofolan (Bilevon-M) and Bromophenophos (Acedist) against fascioliasis was found 98.8, 97.7 and 97.7%, respectively (Saleem *et al.*, 1986). The efficacy of different drugs against

fascioliasis was reported as 93.24% for oxyclozanide, 90.41% for nitroxynil and 86.67% for hexachlorophene on day 21 post-treatment (Ahmad *et al.*, 1983). Maqbool and Irfan (1983) reported oxyclozanide, hexachlorophene and nitroxynil being 85.7, 82.8 and 80% effective against fascioliasis in buffaloes after single dose, and 100, 97.1 and 95.7% effective after the second dose, respectively. Hussain (1990) found Trodax and Ranide being 82.05% and 87.50% effective against fascioliasis in cattle. Ashraf (1994) reported Albendazole and Niclosamide being 96.02-99.23%, and 100% effective against cestodes.

Dagra (1974) evaluated the effects of fortnight dosing of piperazine compounds versus daily small dosing of phenothiazine against *Ascaridia galli* in poultry and it was concluded that piperazine citrate was the medicine of choice in the treatment of *Ascaridia galli* in poultry. Elahi (1982) investigated efficacy and safety of single oral dose treatment with piperazine (200 mg/kg), santonin (15,30 and 60 mg/kg) and oxfendazole (7.5 mg/kg) against experimentally produced *Ascaridia galli* infection in local chickens. The santonin @ 60 mg/kg was found equieffective to piperazine @ 200 mg/kg.

Qudoos (1994) reported ivermectin, the best acaricide followed by diazinon and trichlorphon for the treatment of mange in cattle and buffaloes. Rana (1993) reported 0.15% Neguvon to be highly effective in sheep with mange/mite infection with genera Sarcoptes, Psoroptes and Chorioptes. Khan (1993) used Ectopar, Asuntol and Neocidal against *R. sanguineus* ticks in sheep and found 100, 93.6 and 89.5% respective efficacy.

Ashraf *et al.* (1985) determined efficacy of nitrofurazone, sulphaguanidine and terramycin against coccidiosis, and reported nitrofurazone being the most effective in reducing the faecal oocyst counts and better body weight gains in treated lambs. Omar (1988) reported amprolium, clopidol and nitrofurazone effective against coccidiosis in sheep, but amprolium was found to be better than the other two drugs. Akhtar and Riffat (1987) evaluated anticoccidial activity of *Melia azedarach*, Linn. seeds (bakain) in chickens naturally infected with a mixed gastrointestinal Eimeria infection. *Melia azedarach* powder was found to cause OPG reduction in the chicks @ 20 mg/kg being 83±19% on day 15 post-treatment (PT) which was non-significantly different from that of control drug. Likewise, methanol extract of *Melia azedarach* (=20 mg/kg body weight powder) reduced OPG by 79±14% on day 15 PT, being non-significantly ($P<0.05$) different from the control drug. However, due to mortality in chiks treated with *Melia azedarach*, it was not recommended until detailed experiments are conducted.

Iqbal *et al.* (2000) studied effect of urea on the development and survival of *Haemonchus contortus* eggs and larvae with an objective to workout its feasibility for control on pastures/farm premises. Urea solutions delayed hatching and development of eggs of *Haemonchus contortus* at lower concentrations (2.5 to 5.0%) and proved lethal at higher (>5-10%) concentrations. Therefore, urea may be used on farm premises or on pastures in 5-10 % concentrations for the control of Haemonchosis. However, further studies are suggested for standardisation of rate and mode of application of urea.

Iqbal et al. (2001) evaluated the aqueous extract of sorghum (*Sorghum bicolor*) for its *in vitro* inhibitory effects on the hatching and moulting of eggs of *Haemonchus (H) contortus*. The eggs were recovered from adult female *H. contortus* and cultured on faecal medium. The cultures were sprayed with aqueous extracts of sorghum derived from dried field grown sorghum plants in the ratio of 1 g herbage : 20 mL water. Hatching of *H. contortus* eggs on day 2 post treatment in sorghum extract treated cultures was 5.8%; whereas, it was 69.8% in cultures treated with distilled water. However, only rare ($\leq 4\%$) L_1 moulted to L_3 in sorghum treated cultures in contrast to control (distilled water) where, 45% eggs developed to L_3. It was concluded that Sorghum possesses inhibitory effects on the hatching and moulting of eggs of *H. contortus*.

Iqbal *et al.* (2001a) screened methanol extracts of some commonly used plant materials of ethnoveterinary importance in Pakistan for their *in vitro* anthelmintic activity. Results revealed that *Zingiber officinale* killed all

the test worms (*Haemonchus contortus*) within two hours post exposure being 100% effective. *Allium sativum* and *Cucurbita mexicana* extracts were equally effective at 2 and 4 h post exposure; by 6 h post exposure, however, the earlier was 100% effective; whereas, *C. mexicana* could not kill all the worms and was 83.4% effective. *Ficus religiosa* was 100% effective by 4 h post exposure, and was as good as *A. sativum* and *Z. officinale* by 6 h post exposure. Majority of the worms exposed to control (normal saline) remained alive till 4 h post exposure, and thereafter, 50% of them died by 6 h post exposure. It was concluded that all the studied plants had some anthelmintic activity, therefore, *in vivo* trials may be conducted for further evidence for their use in animals on scientific basis.

Munir *et al.* (2001) investigated the effects of Sodium Chloride (NaCl) and Calcium Carbonate ($CaCO_3$) on the development and survival of *Haemonchus (H) contortus*. The egg hatching started from day 2 post treatment (PT) at all concentrations of NaCl. However, there was a gradual decrease in hatching with increasing concentrations of NaCl and the total number of eggs hatched was lower in NaCl treated groups compared with control. Rare eggs hatched to L_1 in 10.0% $CaCO_3$ concentrations. This indicated destructive effects of $CaCO_3$ on eggs and larvae of *H. contortus*. The eggs of *H. contortus* hatched to L_1, L_2 and L_3 in 2.5% $CaCO_3$ solution. However, per cent hatching and subsequent moulting to L_2 and L_3 was lower as compared to control. It was concluded that NaCl and $CaCO_3$ can be used on farm premises and pastures in safer doses to prevent development of eggs of *H. contortus* and their transmission to the animals.

CONCLUSIONS

Based on the review of the parasitic research in Pakistan, the following conclusions are drawn:

1. More than 200 post graduates have been produced in the field of Veterinary Parasitology by different institutions in the country.
2. Fascioliasis, parasitic gastro-enteritis, hydatidosis, coccidiosis, ectoparasitism, theleriosis and babesiosis are the major parasitic problems of ruminants in the order of priority.
3. Main stress of research has been given on the helminth problems and protozoan diseases have been ignored except coccidiosis.
4. Coccidiosis, helminth infections and ticks have been noted as major parasitic problems of poultry industry.
5. The parasitic research has been focused to a limited part of the country, particularly around the areas where universities are located.
6. There is lot of duplication in research and it seems unplanned, untargeted and more of academic nature indicating lack of co-ordination among different institutions.
7. There is an urgent need of linking different institutions working on parasites to collectively plan objective oriented research of applied nature in order to give practical solutions to the diseases mentioned above.
8. Most of the research carried out remains unpublished, therefore, is limited to the thesis produced for the award of postgraduate degrees.
9. The parasitological procedures and experimental designs by many workers does not match with the international standards/developments in the field of veterinary parasitology.

RECOMMENDATIONS

1. The parasite research should be extended to broader area keeping in view various agro-ecological zones of the country.
2. There is an urgent need to carry out research on applied aspects leading towards control of parasites.

3. The research so far conducted lacks in detection of anthelmintic resistance, therefore, future planning be done keeping in view this aspect.
4. Efforts should be made to exploit indigenous resources for parasite control, particularly the scientific evaluation of traditionally inherited knowledge of plants having antiparasitic properties.
5. The researchers/institutions should be provided with adequate research funds and laboratory facilities.
6. The libraries of the institutions be strengthened utilizing the information technology, which will also facilitate in establishment of international linkages.

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